when I found that it had decreased in brightness by a whole magnitude. No opportunity for observation has since been lost, and the determinations are as follows :

	Dec. 3.	Dec. 5.	Dec. 7.	Dec. 8 (sky becoming foggy).	
	10·50	10·44	10·56	10·55	
from	(12)	(15)	(17)	(6)	comparison stars,

with a redetermination of their magnitudes.

As previously intimated the scale on which these estimations have been made will probably require revision when standard photometric values of the brightness of the comparison stars have been published elsewhere ; but it seemed advisable, in view of this large change of brightness, to enlist the attention of observers who can follow the star with effective instruments should it continue to decrease to the point of visual extinction.

The colour has been red throughout, increasing as the star diminished, as was the case in the early changes of *Nova Persei.* Photographs taken with the 24-inch refractor of this Observatory on October 8 and December 5 show the change of photographic effect very markedly.

Radcliffe Observatory, Oxford:
1904 *December* 8.

On the Relative Brightness of Binary Stars.
By J. E. Gore, F.R.A.S.

In my *Catalogue of Binary Stars*, published by the Royal Irish Academy in 1891, I gave the "relative brightness" and "hypothetical parallax" for all the binary stars for which orbits had then been computed. The "relative brightness" was calculated from Mr. Monck's formula, the standard star being ξ *Ursæ Majoris*, of which the brightness was assumed as unity. Since that time numerous other orbits have been computed. From all these orbits I have selected those which seem to be the most accurately determined, and have recomputed the "relative brightness" and "hypothetical parallax" of forty-eight binary stars. My former catalogue contained fifty-nine stars, but for some of these the orbits have not proved satisfactory, and better orbits have been computed for others. I have adopted Dr. See's orbit for ξ *Ursæ Majoris*, and with his values of P, the period in years, and a, the semi-axis major in seconds of arc, Mr. Monck's formula becomes

$$k = 10^{0·4(3·86-m)}\left(\frac{\text{P}}{60·0}\right)^{\frac{4}{3}}\left(\frac{2·508}{a}\right)^{2}.$$

I have used the Harvard photometric magnitudes of the stars, and have given the spectrum as observed at Harvard, A being the first or Sirian type, F intermediate between first and second types, G second or solar type, and K intermediate between second and third types

If M be the mass of a binary system, and p the parallax,

$$M = \frac{a^3}{p^3 P^2}.$$

Putting M = 1, we have

$$p = \frac{a}{P^{\frac{2}{3}}},$$

which is the "hypothetical parallax" on the assumption that the mass of the system is equal to the mass of the Sun. From this it follows that the smaller the parallax the larger the mass, and the greater the parallax the smaller the mass.

Binary Stars.

No.	Star.	R.A. 1900·0.	Dec. 1900·0.	Mag.	P Years.	*a*.	Relative Brightness.	*h.p.*	Spectrum.	Computer of Orbit.
		h m	° ′			″		″		
1	Σ 3062	0 1	+57 53	6·10	104·6	1·37	0·89	0·06	F	See
2	η Cassiopeiæ	0 43	+57 17	3·64	500	11·4	1·36	0·18	F8G	Comstock
3	γ² Andromedæ	1 57·8	+41 51	5·00	55·0	0·34	16·37	0·024	A	Hussey
4	Σ 228	2 7·6	+47 2	6·03	88·7	0·98	1·49	0·05	F	Gore
5	40(o²) Eridani	4 10·7	− 7 49	9	180·0	4·79	0·01	0·15	...	Doolittle
6	55 Tauri	4 14·2	+16 18	6·86	200	0·85	2·73	0·025	E	Hussey
7	OΣ 82	4 17·1	+14 51	6·54	97·9	0·94	1·06	0·04	H	Hussey
8	β 883	4 44·6	+10 52	6·5	15·8	0·24	1·62	0·04	...	Lewis
9	Sirius	6 40·7	−16 35	−1·58	51·1	7·77	12·61	0·56	A	Zweirs
10	Castor	7 28·2	+32 6	1·58	346·8	5·75	16·08	0·116	A	Doberck
11	Procyon	7 34·1	+ 5 29	0·48	40·0	5·84	2·41	0·50	F5G	See
12	9 Argûs	7 47·1	−13 38	5·30	23·3	0·61	18·04	0·074	E	Burnham
13	ζ Cancri	8 6·5	+17 57	4·71	60·0	0·86	3·90	0·056	F	See
14	Σ 3121	9 12·0	+29 0	7·26	34·0	0·67	0·287	0·06	E	See
15	ω Leonis	9 23·1	+ 9 30	5·55	116·2	0·88	4·11	0·037	E	See
16	φ Ursæ Maj.	9 45·4	+54 32	4·54	99·7	0·32	64·62	0·015	A	Doberck
17	ξ Ursæ Maj.	11 12·9	+32 6	3·86	60·0	2·50	1	0·163	G	See
18	OΣ 234	11 25·4	+41 51	6·99	77·0	0·34	4·08	0·02	E (?)	See
19	OΣ 235	11 26·7	+61 38	5·38	66·0	0·83	3·47	0·05	F	Hussey
20	γ Centauri	12 36·0	−48 25	2·38	88·0	1·02	39·08	0·05	A	See
21	γ Virginis	12 36·6	− 0 54	2·91	194·0	3·99	5·60	0·119	F	See
22	42 Comæ Ber.	13 5·1	+18 4	4·47	25·5	0·64	2·85	0·074	F	See
23	25 Can Ven.	13 33	+36 48	4·92	184	1·13	8·26	0·035	A	See

No.	Star.	R.A. 1900·0.	Dec. 1900·0.	Mag.	P Years.	*a*.	Relative Brightness.	*h.p.*	Spectrum.	Computer of Orbit.
		h m	° ′			″		″		
24	Σ 1785	13 44·6	+29 29	7·26	199·2	2·55	0·22	0·07	...	Biesbroeck
25	α Centauri	14 32·8	−60 25	0·06	81·1	17·70	0·99	0·94	{G K5M}	See
26	OΣ 285	14 41·7	+42 48	7·24	97·9	0·34	4·65	0·016	...	Biesbroeck
27	ξ Boötis	14 46	+19 31	4·64	148·4	5·00	0·41	0·17	G	Biesbroeck
28	η Cor. Bor.	15 19·1	+30 39	5·13	41·6	0·86	1·43	0·076	F	Comstock
29	μ² Boötis	15 20·7	+37 41	6·67	219·4	1·26	1·63	0·034	...	See
30	OΣ 298	15 32·5	+40 8	6·69	56·6	0·88	0·55	0·06	...	Celoria
31	γ Cor. Bor.	15 38·5	+26 37	3·93	73·0	0·73	13·02	0·04	A	See
32	σ Cor. Bor.	16 10·9	+34 7	5·43	370·0	3·82	1·15	0·074	E	See
33	ζ Herculis	16 37·5	+31 47	3·00	35·0	1·43	3·29	0·134	G	See
34	β 416	17 12·1	−34 53	5·94	34·5	2·13	0·098	0·20	...	Gore
35	Σ 2173	17 25·2	− 0 58	5·26	46·0	1·14	0·93	0·09	F (?)	See
36	μ′ Herculis (BC)	17 42·6	+27 47	9	45·0	1·39	0·02	0·108	...	See
37	τ Ophiuchi	17 57·6	− 8 11	4·88	230·0	1·25	9·38	0·033	F	See
38	70 Ophiuchi	18 0·4	+ 2 31	4·07	88·4	4·55	0·42	0·229	K	See
39	99 Herculis	18 3·2	+30 33	5·26	64·5	1·28	1·16	0·08	F	Doberck
40	ζ Sagittarii	18 56·2	−30 1	2·71	21·6	0·57	14·02	0·07	A2F	Doberck (1904)
41	γ Cor. Aust.	18 59·6	−37 12	4·26	152·7	2·45	2·51	0·085	F8G	See
42	OΣ 400	20 6·9	+43 39	7·14	79·7	0·57	1·35	0·03	H (?)	Hussey
43	β Delphini	20 32·9	+14 15	3·72	27·7	0·67	5·63	0·07	F5G	See
44	4 Aquarii	20 46·1	− 6 0	6·03	129·0	0·73	4·41	0·028	A	See
45	δ Equulei	21 9·6	+ 9 36	4·61	5·7	0·28	1·74	0·09	F	Hussey
46	τ Cygni	21 10·8	+37 37	3·82	36·5	0·94	3·80	0·085	F	Burnham
47	κ Pegasi	21 40·1	+25 11	4·27	11·4	0·42	2·62	0·08	F5G	See
48	85 Pegasi	23 56·9	+26 33	5·82	24·0	0·89	0·38	0·107	E	See

Taking the mean of each class of spectrum we have the following results:

Spectrum.	Mean Relative Brilliancy.			Spectrum.	Mean Relative Brilliancy.		
A	21·81	From	8 orbits	F8G	1·93	From	2 orbits
A2F	14·02	„	1 „	G	1·42	„	4 „
E	4·40	„	7 „	H	1·06	„	1 „
F	3·05	„	12 „	K	0·42	„	1 „
F5G	3·55	„	3 „				

Here we have an almost regular decrease in relative brightness from spectrum A to spectrum K.

Omitting *Sirius*, *α Centauri*, and *Procyon*, which seem to be exceptionally near stars, we have the following results for the "hypothetical parallax:"

Spectrum.	Mean *h.p.*	Spectrum.	Mean *h.p.*
	″		″
A	0·044	F8G	0·133
E	0·057	G	0·156
F	0·070	K	0·229
F5G	0·075		

showing a regular increase in the "hypothetical parallax" from spectrum A to spectrum K.

Notes on the above List.

1. Σ 3062. Components about 6·4, 7·0; colours yellowish and bluish white.

2. η Cassiopeiæ. Components 4 and 7; colours yellowish and purple. O. Struve found a parallax of 0″·154, and a parallax of 0″·3743 was found by Schweizer-Socoloff. With Struve's parallax mass of system = 1·6222 × Sun's mass.

3. γ^2 Andromedæ (B.C.) Components 5, 5·7; bluish. Orbit very eccentric and inclination high.

5. 40 (o^2) Eridani (B.C.) = Σ 518. Components 9, 10·8; yellow, orange. Gill found a parallax of 0″·166, Hall 0″·223. With Gill's parallax mass of system = 0·6963 × Sun's mass.

7. OΣ 82. Photographic magnitude 6·54. Components 7, 9.

9. Sirius. Components −1·58 and 10; white, yellow. Hussey says Zweir's orbit is "the most reliable that has yet appeared." From this orbit and Gill's parallax of 0″·37 we have mass of system = 3·5465 × Sun's mass. According to Auwers the ratio of the masses is 1 : 2·119. This gives for the masses 2·4094 and 1·1371 in terms of the Sun's mass. The companion being faint in proportion to its mass the relative brightness is evidently very small, and therefore the "relative brightness" of Sirius itself is probably considerably higher than that given in the table.

10. Castor. Components 1·99, 2·85; greenish. The brighter component is a spectroscopic binary with a relatively dark companion. Period 2·98 days. A parallax of 0″·198 was found by Johnson. This would make the mass of the system = 0·2042 × Sun's mass.

11. Procyon. Companion about 13 mag.; purple. Elkin found a parallax of 0″·266, and afterwards 0″·325. The first parallax would give a mass of 6·6, and the second a mass of 3·627 times the Sun's mass. Procyon has a proper motion of 1″·245 in the direction of position angle 214°·6.

12. 9 Argûs. Components 5·7, 6·3; yellow. Burnham says that his orbit represents recent measures satisfactorily. According to Auwers the star has a proper motion of 0″·351 in the direction of position angle 195°·4.

13. ζ Cancri (AB). Components 5·5, 6·2; yellow.

14. Σ 3121. Components 7·2, 7·5; white, yellowish.

15. ω Leonis = Σ 1356. Components 6, 7; yellow.

16. φ Ursæ Majoris. Components 5·5, 5·5; yellowish. The "relative brightness" is unusually high and the "hypothetical parallax" very small. With any larger parallax the mass of the system would be less than the Sun's mass.

17. ξ Ursæ Majoris. Components 4·41, 4·87, Harvard. This is the standard star used in the calculations of "relative brightness." A number of orbits have been computed, but in all the periods lie between fifty-eight and sixty-three years, and in most of them between sixty and sixty-two years. See says

"the orbit of ξ Ursæ Majoris is practically all that can be desired in the present state of double star measurement," and he thinks that the parallax may be comparatively large. With the computed hypothetical parallax I find that the Sun would be reduced to 4·00 magnitude, or about the same brightness as the star. According to Lewis the mass of the companion is greater than the mass of the primary star in the ratio of 3 : 2 (*The Observatory*, 1904 November). ξ Ursæ Majoris is also a spectroscopic binary, so that the system is really a triple one.

18. OΣ 234. Components 7, 7·8; yellowish.

19. OΣ 235. Components 6, 7·8; yellowish. The orbit is somewhat doubtful according to Hussey.

20. γ Centauri. Components 3, 3; yellowish.

21. γ Virginis. Components 3·65, 3·68, Harvard. Orbit good. Belopolsky found a parallax of 0″·051 and a mass equal to fifteen times the Sun's mass.

22. 42 Comæ Berenicis. Components 5·2, 5·2; orange. Orbit satisfactory.

23. 25 Canum Venaticorum. Components 5, 8·5; white, blue.

24. Σ 1785. Components 7·3, 7·5; pale yellow, bluish. Orbit published in 1904.

25. α Centauri. Components 0·36 (spectrum G) and 1·61 (spectrum K 5 M), Harvard. Both orange yellow. A parallax of 0″·75 was found by Gill, and 0″·76 by Wright and Palmer from spectroscopic measures of relative velocity. With Gill's parallax mass of system = 2·00 × Sun's mass. Masses of components nearly equal. If we take the density of companion as 2·0 (Sun = 1·4), I find luminosity of primary = 2·52 × luminosity of companion or relative brightness = 0·39.

26. OΣ 285. Components 7·5, 7·6; yellowish, whitish. Spectrum not in the Draper Catalogue.

27. ξ Boötis. Components 4·7, 6·7; yellow, purple.

28. η Coronæ Borealis. Components 5·5, 6; yellowish.

29. μ^2 Boötis. Components 6·7, 8; white.

30. OΣ 298. Components 7, 7·4; yellowish. Hussey says: "Celoria's period is not far from the truth."

31. γ Coronæ Borealis. Components 4, 7; yellow, blue.

32. σ Coronæ Borealis. Components 6, 7; yellow, bluish.

33. ζ Herculis. Components 3, 6; yellow, bluish. Lewis thinks that the primary star is probably a binary with a period of about twelve years, and a = 0·25 (*Monthly Notices R.A.S.* vol. lxi. No. 2). This would give a relative brightness for the primary star of 25·82, which seems improbable.

34. β 416. = Lacaille 7215. Components 6·4, 7·8; yellowish. Spectrum not in Draper Catalogue.

35. Σ 2173. Components 6, 6; yellow.

36. μ^1 Herculis. Components 9·4, 10; bluish white, bluish. Orbit good. The relative brightness is unusually small, and the hypothetical parallax is comparatively large for so faint a star. Components possibly gaseous.

37. τ Ophiuchi. Components 5, 6; yellowish.

38. 70 Ophiuchi. Components 4·5, 6·0; yellow, purplish. Kruger found a parallax of 0″·169 and 0″·162, and Schur 0″·16. With Schur's parallax the mass of the system would be 2·939 × Sun's mass; but, using the same parallax, M. Adalbert Prey finds the masses of the two components to be 0·32 and 1·28 × Sun's mass; that is, mass of fainter component is four times that of the brighter! (*Popular Astronomy*, 1904 June and July).

39. 99 Herculis. Components 6, 11·7; yellow, purple.

40. ζ Sagittarii. Components 3·9, 4·4; yellowish.

41. γ Coronæ Australis. Components 5, 5; yellowish. Gore's orbit (1892) gives P = 154·41 years and a = 2″·55, differing but little from See's result.

42. OΣ 400. Components 7·5, 8·5. Spect. II.? Not in Draper Catalogue. Burnham's period is 81·04 years; a = 0″·47.

43. β Delphini. Components 4, 6; yellowish. Several other orbits have been computed with periods ranging from 22·97 to 30·91 years.

44. 4 Aquarii. Components $6\frac{1}{2}$, $7\frac{1}{2}$; yellow.

45. δ Equulei. Components 5, 5·5; yellow. Hussey finds mass of system = 1·89 × Sun's mass and parallax = 0″·071, from spectroscopic measures.

46. τ Cygni. Components 4, 10. Burnham thinks the orbit doubtful and suggests that the companion is double, and on this hypothesis he has based his orbit.

47. κ Pegasi. Components 4·5, 5·0; yellowish. The brighter component is a spectroscopic binary. From the spectroscopic measures of 24·8 miles a second and period of six days I find a probable mass of the system = 0·48 × Sun's mass, and a parallax of 0″·106. This would reduce the Sun to a star of about 4·87 magnitude.

48. 85 Pegasi. Components 6, 10; yellowish, bluish. Brunnow found a parallax of 0″·054. This, with See's orbit, gives the mass of the system = 7·77 × Sun's mass. From measures of the binary and a distant 9th magnitude star Comstock, using a parallax of 0″·04, finds a mass of 11·3, the mass of A being 4·3 and that of B = 7·0 in terms of the Sun's mass = 1. With reference to this "remarkable" result he says, "A star A whose spectrum is of the second type (E in the Draper Catalogue) emits more than 100 times the light of its companion B, although B is presumably of equal age with A, and possesses 60 per cent. more mass than the latter star" (*Astrophysical Journal*, vol. xvii. p. 223). The companion is possibly gaseous. 85 Pegasi has a large proper motion of about 1″·3 per annum in the direction of position angle 140°.

On the Relative Efficiency of Different Methods of Determining Longitudes on Jupiter. By A. Stanley Williams.

I have read Professor G. W. Hough's paper "On the Determination of Longitude on the Planet *Jupiter*" in the Supplementary Number of the *Monthly Notices* very carefully, but fail to see any reasons for modifying the conclusions come to in my previous communication on this subject, in the March number. It seems to me that much of what he says has no direct bearing upon the subject and only tends to obscure the real questions at issue, and there are, moreover, several misstatements and misconceptions on his part. The position is simply this: In my previous communication I discussed in a particular manner not merely a few selected observations of a limited number of spots, but a very large amount of work done by Professor Hough with the micrometer upon numerous spots, and in addition I included his fine series of observations of the red spot, made when that remarkable object was at its maximum plainness. The first was to show the degree of accuracy attained by the micrometric method in general work, and the last what could be accomplished under the most favourable circumstances. I also discussed *in exactly the same manner* a correspondingly large number of observations of many different spots by the method of transits, made by various observers, and I came to the conclusion, as the result of this *exactly similar comparison*, that the apparent errors of the observations are about the same with either method, or, in other words, that the two methods